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| 10/767,657      | 01/29/2004  | Chu-Yun Fu           | 677,200-1189        | 5383             |

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EXAMINER

NOVACEK, CHRISTY L

ART UNIT PAPER NUMBER

2822

DATE MAILED: 10/19/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

11.9

|                              |                                |                           |  |
|------------------------------|--------------------------------|---------------------------|--|
| <b>Office Action Summary</b> | Application No.<br>10/767,657  | Applicant(s)<br>FU ET AL. |  |
|                              | Examiner<br>Christy L. Novacek | Art Unit<br>2822          |  |

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --  
**Period for Reply**

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

**Status**

- 1) ☒ Responsive to communication(s) filed on 04 August 2005.
- 2a) ☒ This action is **FINAL**.                      2b) ☐ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

**Disposition of Claims**

- 4) ☒ Claim(s) 1-4, 6-20, 22-26 and 28-34 is/are pending in the application.
- 4a) Of the above claim(s) \_\_\_\_\_ is/are withdrawn from consideration.
- 5) ☐ Claim(s) \_\_\_\_\_ is/are allowed.
- 6) ☒ Claim(s) 1-20, 25, 26, 29 and 32-34 is/are rejected.
- 7) ☒ Claim(s) 22-24, 28, 30 and 31 is/are objected to.
- 8) ☐ Claim(s) \_\_\_\_\_ are subject to restriction and/or election requirement.

**Application Papers**

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on \_\_\_\_\_ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.  
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).  
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

**Priority under 35 U.S.C. § 119**

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All    b) ☐ Some \*    c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_\_.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

\* See the attached detailed Office action for a list of the certified copies not received.

**Attachment(s)**

- |  |   |
|--|---|
| 1) <input checked="" type="checkbox"/> Notice of References Cited (PTO-892)  | 4) <input type="checkbox"/> Interview Summary (PTO-413)<br>Paper No(s)/Mail Date. _____ |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948)                                   | 5) <input type="checkbox"/> Notice of Informal Patent Application (PTO-152)             |
| 3) <input type="checkbox"/> Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)<br>Paper No(s)/Mail Date _____ | 6) <input type="checkbox"/> Other: _____  |

### **DETAILED ACTION**

This office action is in response to the amendment filed August 4, 2005.

#### ***Response to Amendment***

The amendment to the specification is sufficient to overcome the objection to the specification stated in the previous office action. Therefore, this objection is withdrawn.

The amendment of the claims is sufficient to overcome the rejections of claims 17-20, 22-25 and 28-31 under 35 U.S.C. 112, second paragraph stated in the previous office action. Therefore, these rejections are withdrawn.

The limitations added to claims 1 and 16 are sufficient to overcome the Ishitsuka et al. (US 6,242,323), Hong et al. (US 6,566,229), Heo et al. (US 6,683,354) and Ahn (US 6,596,607) references.

#### ***Claim Objections***

Claims 1 and 33 are objected to because of the following informalities: In line 3 of claim 1 and line 2 of claim 33, the word "MSOFET" should be replaced with "MOSFET". Appropriate correction is required.

#### ***Claim Rejections - 35 USC § 112***

The following is a quotation of the second paragraph of 35 U.S.C. 112:

The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

Claims 1-4, 6-15, 26 and 32 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

Regarding claims 1-4, 6-15 and 32, lines 11-12 and 15 of claim 1 recite the limitation of "said plurality". However, line 6 of claim 1 recites the limitation of "a plurality of liner layers", line 7 of claim 1 recites the limitation of "an uppermost plurality of nitride liners" and line 10 of claim 1 recites the limitation of "a plurality of trench filling oxide layers". Therefore, it is unclear as to which of these layers "said plurality" is referring.

Regarding claim 26, claim 26 is dependent upon claim 21. However, claim 21 has been cancelled.

### ***Claim Rejections - 35 USC § 103***

The text of those sections of Title 35, U.S. Code not included in this action can be found in a prior Office action.

Claims 1-4, 6, 12, 16, 19, 20, 25, 29, 33 and 34 are rejected under 35 U.S.C. 103(a) as being unpatentable over Kim et al. (US 6,461,937).

Regarding claims 1, 12 and 33, Kim discloses providing a semiconductor substrate forming a trench in the semiconductor substrate, forming a plurality of liner layers (3, 4, 5, 6) including an uppermost plurality of nitride liners (not numbered) of SiN to line the trench, forming a plurality of trench filling oxide layers of USG (7/8) and removing excess trench filling material above the trench level (Fig. 5; col. 10, ln. 47 - col. 11, ln. 25). Kim does not specifically disclose that, in this embodiment of the invention, the trench filling oxide layers are thermally annealed. However, in every other embodiment of the invention disclosed by Kim, the trench filling oxide layers are thermally annealed to densify the trench filling layers and make it less susceptible to being etched in subsequent process steps (col. 6, ln. 45-51). At the time of the invention, it would have been obvious to one of ordinary skill in the art to thermally anneal the

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trench filling oxide layers of Kim because in every other embodiment taught by Kim, a thermal anneal process is conducted on the trench filling oxide in order to densify it.

Kim does not disclose that the thermal anneal results in the trench filling oxide layers to be substantially free of stress. However, the thermal annealing process of the trench filling layers of Kim appears to be the same as the stress-reducing heat treatment process of Applicant's (e.g., both processes involve annealing the trench filling oxide at temperatures of around 800-1100°C). Therefore, it appears that the trench filling oxide layers of Kim would inherently have the same stress profile as that of Applicant's. See *In re Swinehart*, 439 F.2d 210, 212-13, 169 USPQ 226, 229 (CCPA 1971) "where the Patent Office has reason to believe that a functional limitation asserted to be critical for establishing novelty in the claimed subject matter may, in fact, be an inherent characteristic of the prior art, it possesses the authority to require the applicant to prove that the subject matter shown to be in the prior art does not possess the characteristics relied on"); and *In re Fitzgerald*, 619 F.2d 67, 205 USPQ 594 (CCPA 1980) (a case indicating that the burden of proof can be shifted to the applicant to show that the subject matter of the prior art does not possess the characteristic relied on whether the rejection is based on inherency under 35 U.S.C. 102 or obviousness under 35 U.S.C. 103).

Regarding claim 2, Kim discloses forming a patterned hardmask layer of silicon nitride (col. 10, ln. 50-51; col. 5, ln. 40-45).

Regarding claim 3, Kim discloses that the substrate is made of a semiconductor material, but Kim does not specifically disclose that the substrate is made of silicon. At the time of the invention, it would have been obvious to one of ordinary skill in the art to use a silicon substrate

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for the semiconductor substrate disclosed by Kim because silicon is the most widely used and conventional semiconductor material on which integrated circuits are formed.

Regarding claim 4, Kim discloses that the liner layer is made by thermal oxidation (col. 10, ln. 54-55).

Regarding claim 6, Kim discloses that the nitride liner layers are formed by depositing with a CVD process (col. 6, ln. 21-25).

Regarding claim 16, Kim discloses a semiconductor substrate, a trench in the semiconductor substrate, a plurality of liner layers (3, 4, 5, 6) including an uppermost plurality of nitride liners (not numbered) of SiN lining the trench and a plurality of trench filling oxide layers of USG (7/8) on the plurality of nitride liners (Fig. 5; col. 10, ln. 47 - col. 11, ln. 25). Kim does not specifically disclose that, in this embodiment of the invention, the trench filling oxide layers are thermally annealed. However, in every other embodiment of the invention disclosed by Kim, the trench filling oxide layers are thermally annealed to densify the trench filling layers and make it less susceptible to being etched in subsequent process steps (col. 6, ln. 45-51). At the time of the invention, it would have been obvious to one of ordinary skill in the art to thermally anneal the trench filling oxide layers of Kim because in every other embodiment taught by Kim, a thermal anneal process is conducted on the trench filling oxide in order to densify it.

Kim does not disclose that the thermal anneal results in the trench filling oxide layers to be substantially free of stress. However, the thermal annealing process of the trench filling layers of Kim appears to be the same as the stress-reducing heat treatment process of Applicant's (e.g., both processes involve annealing the trench filling oxide at temperatures of around 800-1100°C). Therefore, it appears that the trench filling oxide layers of Kim would inherently have

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the same stress profile as that of Applicant's. See *In re Swinehart*, 439 F.2d 210, 212-13, 169 USPQ 226, 229 (CCPA 1971) "where the Patent Office has reason to believe that a functional limitation asserted to be critical for establishing novelty in the claimed subject matter may, in fact, be an inherent characteristic of the prior art, it possesses the authority to require the applicant to prove that the subject matter shown to be in the prior art does not possess the characteristics relied on"); and *In re Fitzgerald*, 619 F.2d 67, 205 USPQ 594 (CCPA 1980) (a case indicating that the burden of proof can be shifted to the applicant to show that the subject matter of the prior art does not possess the characteristic relied on whether the rejection is based on inherency under 35 U.S.C. 102 or obviousness under 35 U.S.C. 103).

Regarding claim 19, Kim discloses the plurality of trench filling oxide layers includes a portion that extends above the substrate (col. 11, ln. 1-5).

Regarding claim 20, Kim discloses that the portion above the substrate includes an inward edge portion extending higher than an outward edge portion.

Regarding claim 25, Kim discloses that the trench filling oxide layers includes a plurality of USG layers (col. 10, ln. 64 – col. 11, ln. 5).

Regarding claim 29, Kim discloses that the plurality of nitride liner layers is formed on a SiO<sub>2</sub> liner layer (col. 10, ln. 54-55).

Regarding claim 34, Kim discloses that the oxide layers are USG oxide layers.

Claims 7 and 10 are rejected under 35 U.S.C. 103(a) as being unpatentable over Kim et al. (US 6,461,937) in view of Ahn et al. (US 6,596,607, previously cited).

Regarding claim 7, Kim discloses depositing USG but Kim does not disclose the process used to deposit it. Like Kim, Ahn discloses a process of depositing USG into a trench to form a

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shallow trench isolation. Ahn teaches that the USG can be successfully deposited into the trench using a HDP-CVD process (col. 4, ln. 26-30). At the time of the invention, it would have been obvious to one of ordinary skill in the art to deposit the USG layer of Kim using HDP-CVD because Kim does not disclose any particular method of depositing the USG layer and Ahn teaches that HDP-CVD can successfully deposit a layer of USG into a shallow trench isolation.

Regarding claim 10, Ahn discloses that the deposition of the USG layer uses a reactant of TEOS (col. 4, ln. 26-28).

Claim 11 is rejected under 35 U.S.C. 103(a) as being unpatentable over Kim et al. (US 6,461,937) in view of Cui et al. (US 6,693,050, previously cited).

Regarding claim 9, Kim discloses depositing a silicon oxide layer by a HDP-CVD process. However, Kim does not disclose any particular precursors/reactants to be used to form the layer. Like Kim, Cui discloses a process of depositing a silicon oxide layer in a STI. Cui teaches that the silicon oxide layer can be successfully deposited using HDP-CVD with reactants of silane ( $\text{SiH}_4$ ) and  $\text{O}_2$  (col. 5, ln. 20-23). At the time of the invention, it would have been obvious to one of ordinary skill in the art to use silane and oxygen as the reactants to form the silicon oxide layer Kim because Kim does not disclose any particular reactants and Cui discloses that these reactants can successfully be used in a HDP-CVD process to deposit silicon oxide in a STI.

Claims 14, 15, 17 and 18 are rejected under 35 U.S.C. 103(a) as being unpatentable over Kim et al. (US 6,461,937) in view of Ishitsuka et al. (US 6,242,323, previously cited).



Regarding claims 14, 15, 17 and 18, Kim does not disclose rounding the top and bottom corners of the shallow isolation trench or forming the sidewall to have a specific angle, although Kim does disclose angling the sidewalls (Fig. 7). Like Kim, Ishitsuka discloses a process of forming a shallow isolation trench. Ishitsuka discloses that it is preferable to form the isolation trench such that it has sidewalls at an angle with respect to a plane parallel to the substrate major surface of no more than 85 degrees and form the top corners of the trench such that they are rounded because these features allow the sidewalls of the trench to be oxidized without forming stress and deformation of the isolation trench (col. 7, ln. 37-39; Abstract).

#### ***Response to Arguments***

Applicant's arguments with respect to claims 1 and 16 have been considered but are moot in view of the new ground(s) of rejection.

#### ***Allowable Subject Matter***

Claims 8, 9, 26 and 32 would be allowable if rewritten to overcome the rejection(s) under 35 U.S.C. 112, 2nd paragraph, set forth in this office action and to include all of the limitations of the base claim and any intervening claims.

Claims 22, 23, 24, 28, 30 and 31 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

The primary reason for the indication of the allowable subject matter of claims 8, 9, 22, 23, 24 and 26 is the inclusion therein, in combination as currently claimed, of the limitation of forming a shallow trench isolation structure having a plurality of nitride liners lining the trench

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and a plurality of trench filling oxide layers on the nitride liners such that the trench filling oxide layers includes a layer of SOG. This limitation is found in claims 8, 9, 22, 23, 24 and 26 and is neither disclosed nor taught by the prior art of record, alone or in combination.

The primary reason for the indication of the allowable subject matter of claims 28, 31 and 32 is the inclusion therein, in combination as currently claimed, of the limitation of forming a shallow trench isolation structure having a plurality of nitride liners lining the trench and a plurality of trench filling oxide layers on the nitride liners such that the nitride liners are formed of a SiN/SiON or a SiON/SiN stack. This limitation is found in claims 28, 31 and 32 and is neither disclosed nor taught by the prior art of record, alone or in combination.

The primary reason for the indication of the allowable subject matter of claim 30 is the inclusion therein, in combination as currently claimed, of the limitation of forming a shallow trench isolation structure having a plurality of nitride liners lining the trench and a plurality of trench filling oxide layers on the nitride liners such that the nitride liners are formed of a SiO<sub>2</sub>/SiN/SiON stack. This limitation is found in claim 30 and is neither disclosed nor taught by the prior art of record, alone or in combination.

### ***Conclusion***

Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire **THREE MONTHS** from the mailing date of this action. In the event a first reply is filed within **TWO MONTHS** of the mailing date of this final action and the advisory action is not mailed until after

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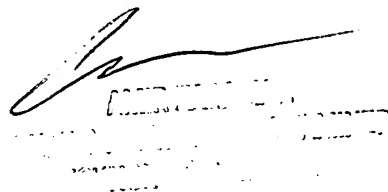
the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Christy L. Novacek whose telephone number is (571) 272-1839. The examiner can normally be reached on Monday-Thursday and alternate Fridays 7:30 - 5:00.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Amir Zarabian can be reached on (571) 272-1852. The fax phone number for the organization where this application or proceeding is assigned is (571) 273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

CLN  
October 17, 2005

A handwritten signature in black ink is written over a rectangular official stamp. The stamp contains the text "Christy L. Novacek" and "Examiner" in a serif font, with "Patent Office" visible at the bottom.